X-ray Microtomography of Geologic Specimens

M. Zhou, D. Lu, J. Dunsmuir, and H. Thomann, (ExxonMobil Research & Engineering)

Abstract No. Zhou5217
Beamline(s): **X2B**

Introduction: Pore connectivity is a controlling parameter for reservoir rock permeability and significantly affects the quantity, rate and type of fluids that will flow. X-ray microtomography provides a rapid and accurate method to nondestructively image the pore network and pore fluid distributions. Nuclear magnetic resonance is a well logging tool used to estimate the type, volume and mobility of reservoir fluids. Existing methods for interpreting NMR logs are empirical and lead to erroneous estimates where reservoir rock differs from that previously observed. Physical insight into fluid displacement and well log response may provide more robust interpretation tools.

Methods and Materials: X-ray microtomography was used to image the three-dimensional pore structure of several sandstone samples with 0.03–3 Darcy permeability and 7-22% porosity. Network models and NMR simulations in the measured pore space were developed to provide a physical basis for interpretive tool development.

Results: We have successfully applied network models derived from three dimensional microCT measured pore structures of several well-characterized reservoir sandstones to calculate fluid saturations, permeabilities and capillary pressure curves that are in excellent agreement with measured values. Simulation of nuclear magnetic resonance (NMR) relaxation spectra calculated from the fluid saturations obtained using network models and experimentally measured pore geometry has provided new insights into methods of interpreting the NMR spectra obtained from well logs in oil exploration.

Conclusions: The simple NMR cutoff model for predicting the volume of fluid bound to the rock matrix by capillary forces is inconsistent with the physical processes controlling displacement. The cutoff model does not include water trapped by displacement processes in pores larger than expected from the relationship between capillary pressure and pore size. A new NMR interpretive method that includes fluid trapped in a fraction of large pores provides an improved estimate.

References: M. Zhou, D. Lu, J. Dunsmuir, and H. Thomann “Irreducible Water Saturation in Sandstone Rock: Two Phase Flow Simulation in CT-based Pore Network”, Phys. Chem., Earth (A), 25, 2, 2000.